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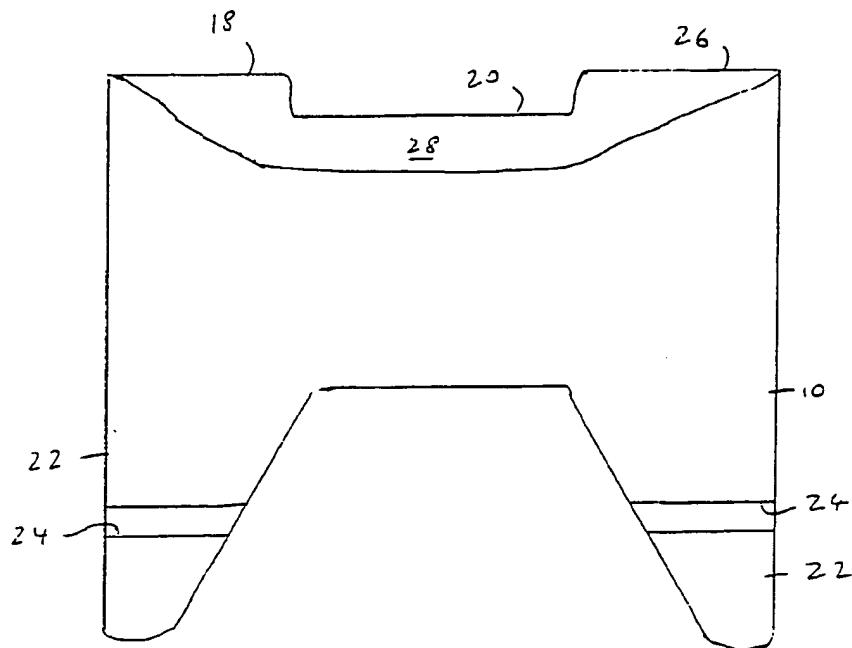
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(54) Title: A PISTON HEAD AND TO A METHOD OF MAKING A PISTON HEAD



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(57) Abstract: The invention provides a piston head (10) having a bowl (20) in the crown (18) thereof. At least the upper edge of the bowl (20), and preferably the whole crown (18) is made of a material resistant to thermal oxidation, such as stainless steel. The remainder of the piston head (10) is made of conventional hot forging material.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A piston head and to a method of making a piston head

The invention relates to a piston head and to a method of making a piston head.

- 5 It is known to shape the surface of a piston head which faces the combustion chamber, i.e. the crown surface, with a central recess or "bowl". Due to the increasingly high compression pressures and temperatures used in modern diesel internal combustion engines, there is a tendency for the bowl in the crown of the piston head to undergo degradation by thermal oxidation and consequently to crack around the sides of the
- 10 bowl and particularly around the entrance to the bowl over time. Materials are known which would provide better resistance to thermal oxidation and the resulting cracking, for example, stainless steel, but cannot be forged as easily as conventional material and are more expensive.
- 15 According to the invention there is provided a piston head having a bowl in the crown thereof, at least the upper edge of the bowl being made of a material resistant to thermal oxidation and another part of the piston head being made of a different material.

In this way, the bowl is protected from thermal oxidation because of the use of a
20 suitably resistant material, but another part of the piston head is made of a different material and can be made of conventional hot forging material so that the piston head can be forged in the usual way without the difficulty and expense involved in moving to a construction where the piston head is made entirely of thermal oxidation resistant material.

Preferably, at least the lead-in to the bowl and the walls of the bowl are made of the thermal oxidation resistant material. In a preferred embodiment, the whole of the crown is made of the thermal resistant material. The thermal resistant material may be any suitable material and may be, for example, stainless steel. In one embodiment, the
5 said other part of the piston head constitutes the remainder of the piston head.

According to another aspect of the invention there is provided a method of making a piston head having a bowl in the crown, the method comprising hot forging a billet comprising one part made of thermal oxidation resistant material and another part made
10 of a material for hot forging, such that the forged piston head has a bowl in the crown and at least the upper edge of the bowl is made of the thermal oxidation resistant material.
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The two said parts of the billet are preferably fixed together prior to hot forging. The
two said parts of the billet may be fixed together in any suitable way and may be
welded together for example by flash butt welding, or may be diffusion bonded
together, but preferably the two said parts are friction welded together. This method is
simple and inexpensive but provides a very strong connection.

20 According to a further aspect of the invention there is provided a piston head hot forged from a billet comprising one part made of a thermal oxidation resistant material and another part made from a material for hot forging, the piston head having a bowl in the crown and at least the upper edge of the bowl being made from the thermal oxidation
resistant material.

Clearly the method is of wider application and could be used in numerous circumstances where it is desired to use the hot forging technique, but where part of the article would benefit from fabrication in a material other than a conventional hot forging material.

According to another aspect of the invention there is provided a method of making an article, the method comprising hot forging a billet comprising one part made of a material for hot forging and another part made from a different material.

10 According to a further aspect of the invention there is provided an article hot forged from a billet comprising one part made of a material suitable for hot forging and another part made of a different material.

An embodiment of the invention will now be described by way of example and with
15 reference to the accompanying drawings, in which:

Fig 1 is a perspective view of the piston head of the embodiment;

Fig 2 is a cross section of the piston head of the embodiment at A-A of Fig 1; and,

Fig 3 is a perspective view of the billet to be hot forged into the piston head of the embodiment.

In order to make the piston head 10 of the embodiment a cylindrical billet 12, as shown in Figure 3, is prepared by friction welding together two cylindrical parts 14,16 of common diameter. The top part 14 of the resulting billet 12 is made of stainless steel and the lower part 16 of the billet 12 is made of a conventional hot forging material for 5 making piston heads, in this case the steel SE 4140. The top part 14 may be about 40% of the total height of the billet 12.

The billet 12 is hot forged in conventional fashion and the resulting piston head 10 is shown in Figures 2 and 3. The piston head 10 is of known shape and consists of a 10 crown 18 in which a bowl 20 is defined coaxially therewith. The piston head 10 has two ears 22 depending therefrom at opposite sides of the piston head 10. The ears 22 define apertures 24, the axes of which are collinear, the apertures 24 in the ears 22 being arranged to receive a gudgeon pin (not shown) to mount a connecting rod (not shown) of a diesel internal combustion engine in conventional fashion.

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As seen in Figure 2, the distribution of the stainless steel after hot forging is such that it makes up the entirety of the top surface 26 of the crown 18 of the piston head 10 including the whole of the bowl 20. Indeed, the stainless steel layer 28 in the piston head 10 has a reasonably uniform depth or thickness around the bowl 20, the thickness 20 of the stainless steel layer 28 then decreasing steadily towards the edges of the top surface 26 of the crown 18.

In this way, the piston head 10 will be much less prone to cracking due to the high compression ratios of modern diesel engines and the subsequent pressure to which it

will be subjected in use because the area with the greatest risk of cracks appearing, namely around the bowl 20 and in the walls of the bowl 20, is made of stainless steel, which has a much greater resistance to thermal oxidation than conventional hot forging material for piston heads. The ears 22 however, which would be difficult to hot forge 5 in stainless steel, are still made in the conventional material and so the pressure under which the billet 12 is hot forged does not need to be increased in spite of the presence of the stainless steel, so that no additional energy is required to result in this more robust construction.

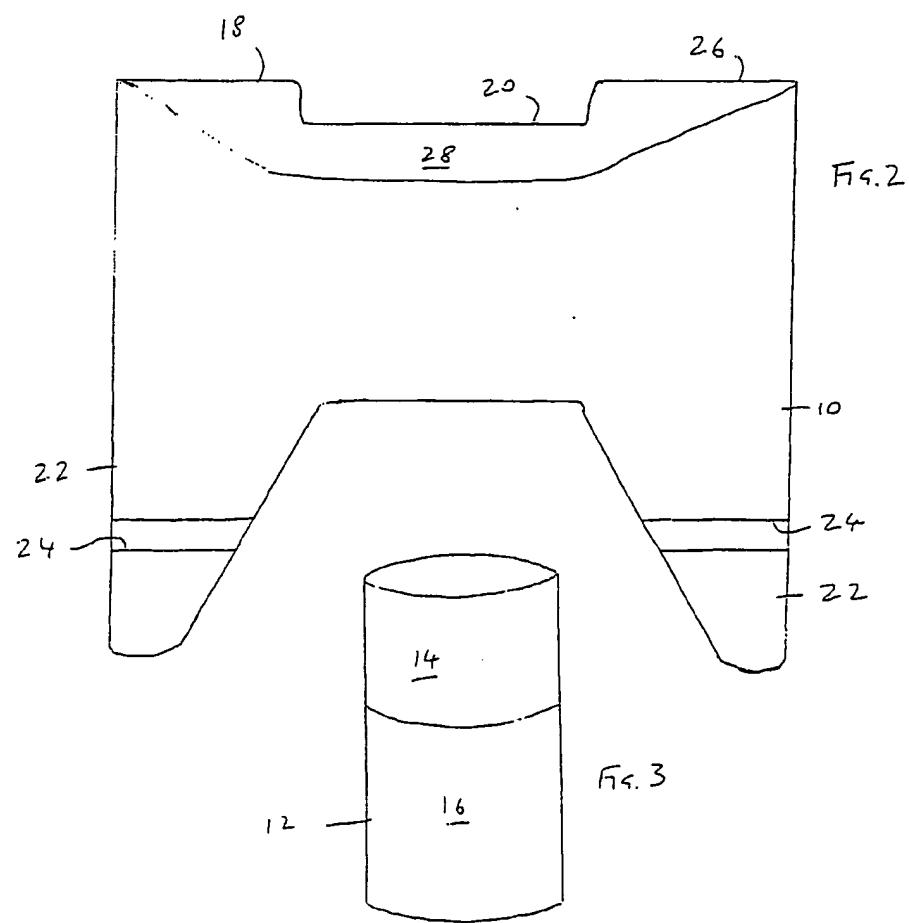
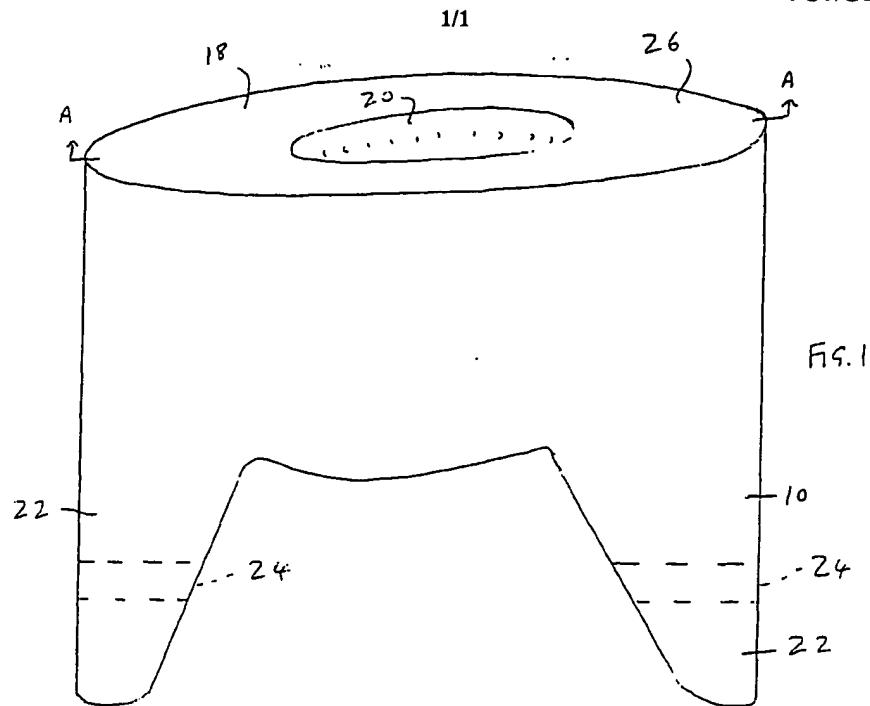
Claims

1. A piston head having a bowl in the crown thereof, at least the upper edge of the bowl being made of a material resistant to thermal oxidation and another part of the piston head being made of a different material.
2. A piston head as claimed in claim 1, wherein the said other part of the piston head is made of conventional hot forging material .
3. A piston head as claimed in claim 1 or claim 2, wherein at least the lead-in to the bowl is made of thermal oxidation resistant material.
4. A piston head as claimed in claim 1, 2 or 3, wherein at least the walls of the bowl are made of thermal oxidation resistant material.
5. A piston head as claimed in claim 4, wherein the floor of the bowl is made of the thermal oxidation resistant material.
6. A piston head as claimed in any preceding claim, wherein the whole of the crown is made of thermal oxidation resistant material.
7. A piston head as claimed in any preceding claim, wherein the thermal oxidation resistant material is stainless steel.

8. A method of making a piston head having a bowl in the crown, the method comprising hot forging a billet comprising one part made of thermal oxidation resistant material and another part made of a material for hot forging, such that the forged piston head has a bowl in the crown and at least the upper edge of the bowl is made of the thermal oxidation resistant material.
9. A method as claimed in claim 8, wherein the two said parts of the billet are fixed together prior to hot forging.
10. A method as claimed in claim 9, wherein the two said parts are friction welded together.
11. A piston head hot forged from a billet comprising one part made of a thermal oxidation resistant material and another part made from a material for hot forging, the piston head having a bowl in the crown and at least the upper edge of the bowl being made from the thermal oxidation resistant material.
12. A method of making an article, the method comprising hot forging a billet comprising one part made of a material for hot forging and another part made from a different material.
13. A method as claimed in claim 12, wherein the two said parts are fixed together prior to hot forging.

14. A method as claimed in claim 13, wherein the two said parts are friction welded together.

15. An article hot forged from a billet comprising one part made of a material suitable for hot forging and another part made of a different material.



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER IPC 7 F02F3/00 B23P15/00 B21K1/18													
According to International Patent Classification (IPC) or to both national classification and IPC													
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 F02F B23P B21K													
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched													
Electronic data base consulted during the International search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, PAJ													
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">Category *</th> <th style="text-align: left; padding: 2px;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="text-align: left; padding: 2px;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">X</td> <td style="padding: 2px;">US 3 596 571 A (HILL HAROLD T ET AL) 3 August 1971 (1971-08-03) figures 4,6 abstract column 1, line 41 - line 45 column 2, line 49 - line 75 ---</td> <td style="padding: 2px;">1-6,10, 14 7,13,15</td> </tr> <tr> <td style="padding: 2px;">A</td> <td style="padding: 2px;">PATENT ABSTRACTS OF JAPAN vol. 1998, no. 08, 30 June 1998 (1998-06-30) & JP 10 082345 A (YAMAHA MOTOR CO LTD), 31 March 1998 (1998-03-31) abstract ---</td> <td style="padding: 2px;">1,9, 11-13,15</td> </tr> <tr> <td style="padding: 2px;"></td> <td style="padding: 2px; text-align: center;">-/-</td> <td style="padding: 2px;"></td> </tr> </tbody> </table>		Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	US 3 596 571 A (HILL HAROLD T ET AL) 3 August 1971 (1971-08-03) figures 4,6 abstract column 1, line 41 - line 45 column 2, line 49 - line 75 ---	1-6,10, 14 7,13,15	A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 08, 30 June 1998 (1998-06-30) & JP 10 082345 A (YAMAHA MOTOR CO LTD), 31 March 1998 (1998-03-31) abstract ---	1,9, 11-13,15		-/-	
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Date of the actual completion of the International search	Date of mailing of the International search report												
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Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl Fax: (+31-70) 340-3016	Authorized officer Wassenaar, G												

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PCT/GB 01/03002

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 032 570 A (KURITA HIROTAKA ET AL) 7 March 2000 (2000-03-07) figures 1,6,8 abstract claims 1-27 -----	1,9-13, 15
A	EP 0 303 444 A (NGK INSULATORS LTD ;MITSUBISHI MOTORS CORP (JP)) 15 February 1989 (1989-02-15) claim 17; figures 1,4 -----	1,7

INTERNATIONAL SEARCH REPORT

Intef	nal Application No
PCT/GB 01/03002	

Patent document cited in search report	Publication date		Patent family member(s)	Publication date
US 3596571	A 03-08-1971	CH DE ES FR GB NL	495192 A 1933520 A1 369320 A1 2012955 A5 1277579 A 6910855 A	31-08-1970 27-08-1970 16-06-1971 27-03-1970 14-06-1972 19-01-1970
JP 10082345	A 31-03-1998	EP US US	0809050 A1 5992015 A 6209446 B1	26-11-1997 30-11-1999 03-04-2001
US 6032570	A 07-03-2000	NONE		
EP 0303444	A 15-02-1989	JP DE EP US	1045918 A 3877652 T2 0303444 A2 5097807 A	20-02-1989 17-06-1993 15-02-1989 24-03-1992